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Final Report on the Project:
The Extragalactic X-ray Background in the 0.2 - 2 keV range

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This project has led to an important discovery of the hot intergalactic medium at temperatures of a few times 10^6 K. The results were reviewed in an invited talk given by the PI at the IAU Colloquium No. 188: The Hot Universe. Here is a brief summary.

We made the first measurement of the extragalactic 0.7 keV background. We detected the X-ray shadow of a neutral gas cloud in the Magellanic Bridge. Two *ROSAT* PSPC observations of total 104 ks were complemented by a detailed atomic hydrogen mapping of the cloud with both the Parkes 64 m telescope and the Australia Telescope Compact Array. From the detected anti-correlation between the observed background intensity and the atomic hydrogen column density of the cloud, we derived an unabsorbed extragalactic background intensity. We further constrained the point-like source contribution based on the mean spectrum of detected sources and on our early autocorrelation function analysis of the background. We find that our measurement extragalactic background intensity is significantly greater than the total point-like source contribution expected if sources are responsible for all the observed background intensity in the 1-2 keV range. We suggest that a significant fraction of the 0.7 keV background arises in a diffuse hot intergalactic (or intercluster) medium of a few million degrees, as has been predicted in hydrodynamic simulations of the growth of cosmological structure.

For a further confirmation of the theoretical prediction of the hot intergalactic medium, we have conducted a pilot project to search for enhanced X-ray-emitting features near rich clusters of galaxies. We have reported the discovery of an elongated complex of extended X-ray-emitting objects in and around the galaxy cluster A2125, based on an archival deep *ROSAT*/PSPC observation. Using multicolor optical imaging of galaxies in the field, we find that this complex represents a hierarchical superstructure spanning ~ 11 Mpc at the redshift ~ 0.247. The multiple peak X-ray morphology and large blue galaxy fraction of A2125 indicate that the cluster is undergoing a coalescence of subunits. The superstructure contains two additional clusters,

projected at distances of only 3 and 4.3 Mpc from A2125. The most interesting feature is, however, the low-surface-brightness X-ray emission from a moderate galaxy concentration away from individual clusters. The emission likely arises in a hot ($\sim 10^7$ K) intergalactic medium, as predicted in N-body/hydro simulations of structure formation.

These results demonstrate the potential of X-ray observations as a powerful tool to study the large-scale structure of the universe.

A list of the publications under the grant:

- "A2125 and its Environs: Evidence for an X-ray-emitting Hierarchical Superstructure"
  Wang, Q. D., Connelly, A., & Brunner, R. 1997, ApJL, 487, L13
- "Under the Shadow of the Magellanic Bridge: A Measurement of the Extragalactic Background at ~ 0.7 keV"
  Wang, Q. D., & Ye, T. 1996, New Astronomy, 1, 245
- "Discovery of a Candidate Old, Isolated Neutron Star in the Field of a Galactic Cirrus Cloud"
  Stocke, J. T., Wang, Q. D., Perlman, E. S., & Donahue, M. E. 1995, AJ, 109, 1199
- "ROSAT Detection of Diffuse Hot Gas in the Edge-on Disk Galaxy NGC4631"
  Wang, Q. D., Walterbos, R., et al. 1995, ApJ, 439, 381
- "Shadowing the Soft X-ray Background by Infrared Cirrus: A Study of Selected Regions"
  Wang, Q. D. and Yu, K. 1995, AJ, 1995, 102, 698.
- "Soft X-ray Observations of a Complete Sample of X-ray Selected BL Lacertae Objects"
  With Perlman, E. S. et al. 1995, ApJ, 456, 451
- "X-ray Observations of the Hot Intergalactic Medium"
  Wang, Q. D. 1997, an invited talk at The Hot Universe Conference (IAU Colloquium No. 188), eds. K. Koyama, in press
- "ROSAT Galactic and Extragalactic Shadowing Experiments"
  Wang, Q. D. 1994, in "New Horizon of X-ray Astronomy", p609.